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Pimbert, M.

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CIRCULAR FOOD SYSTEMS

Modern industrial food systems are fundamentally unsustainable. The linear structure of the globalized industrial food system is based on the view that natural resources are unlimited in their supply at one end and that the planet has an endless capacity to assimilate pollution and waste at the other end. The scale of the social and environmental costs of this model of food and farming is such that "business as usual" is no longer an option today. There is now a growing consensus among scientists that the emerging context of industrial food and farming requires a major rethink and deep structural changes to ensure food security throughout the world.

The ecological and social footprints of the modern food system can be reduced through a shift from linear to circular systems that imitate the structure and function of natural ecosystems to reduce both external inputs and waste. This entry focuses on the policies and practices needed for a transition toward circular food systems in rural and urban contexts.

Toward Virtuous Circular Systems

The imperative is now for transformation rather than reforms that leave the basic structure of modern food systems unchanged. Whether the primary reason for this is ensuring the security of food supplies, increasing energy and fuel costs, reducing pesticide pollution and impacts on public health, bringing about large cuts in

greenhouse gas emissions—or all of these—a fundamentally different approach is required. To date, national and international policy makers have largely ignored calls for a fundamental rethink, leaving many questions unanswered. For example, can the current systems of food production, processing, packaging, distribution, and retail achieve the required cuts in greenhouse gas emissions or will alternative systems need to be developed? How will global food systems—and the transport systems they depend on—be powered following the fossil fuel era?

An alternative to the dominant linear model is to develop multifunctional and productive systems that reduce external inputs, pollution, and waste (as well as dependency and costs). It has been asserted that this can best be achieved by adopting a circular metabolism that reflects the natural world. There are two ecological design principles here: The first is that nature is based on nested and interacting cycles—for example, carbon, nitrogen, phosphorus, and water. The second is that "waste" is converted into a useful form by natural processes and cycles, ensuring that waste from one species becomes food for other species in the ecosystem.

When these principles are applied to human needs, it is possible to design systems and human settlements that provide food, energy, and water through re-integrating food, energy, and water systems in locally embedded circular models. To date, most sustainable food, water, energy, and waste systems have been implemented in isolation. However, greater synergy is possible when ecological agriculture, local food systems, renewable energy systems, and sustainable water and waste management systems are all integrated from the outset and developed simultaneously within a circular economy model. Circular systems minimize the consumption of fossil fuels and other finite resources, and they also encourage recycling and reuse of all resources. In the process, greenhouse gas emissions, air pollution, water pollution,

and solid waste are minimized (Figure 1).

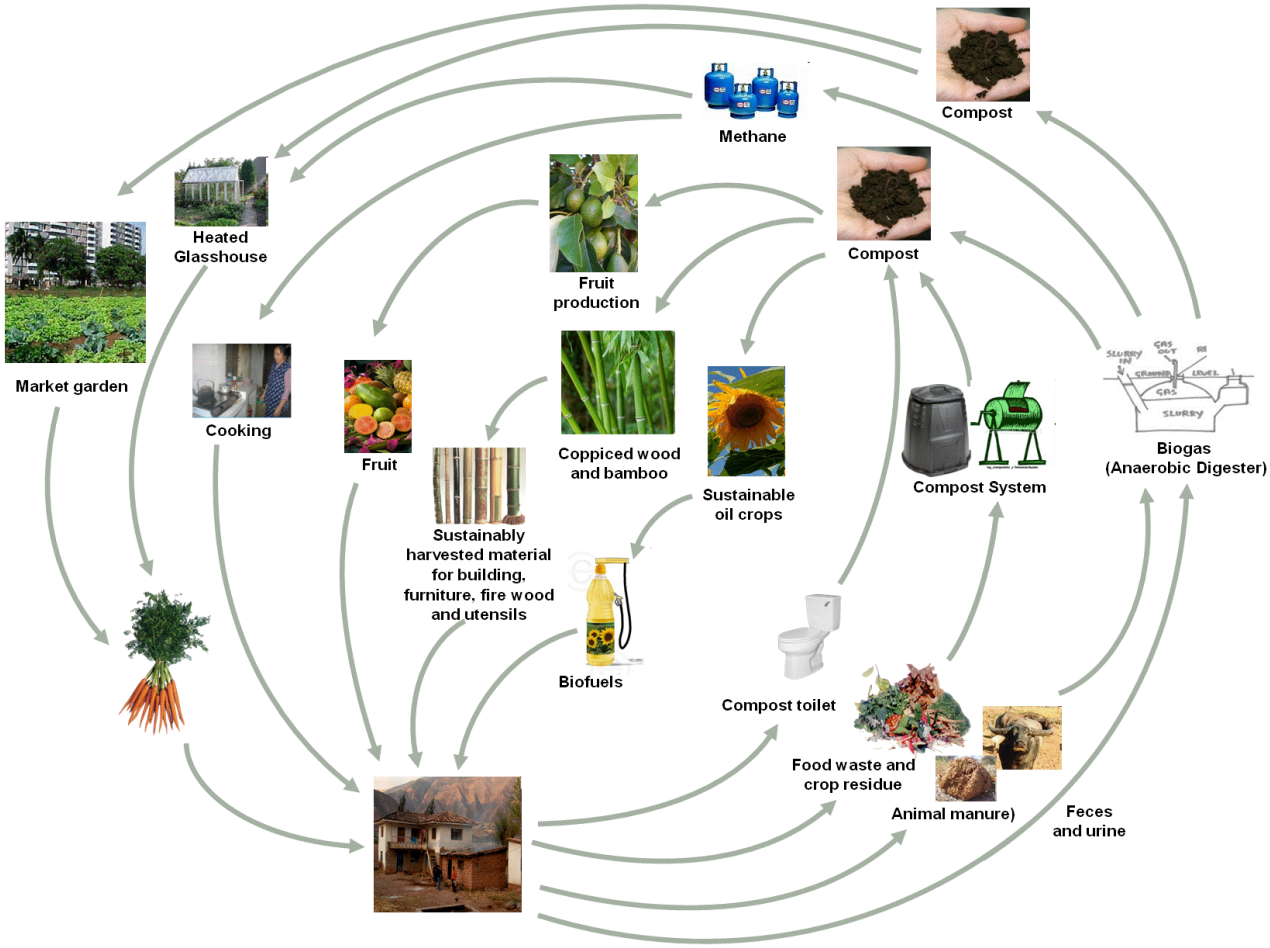

Figure 1 A composting and biogas system to provide food, household and farm energy needs, fertilizer for crops and trees, and construction materials

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Key Characteristics of Circular Systems

Circular systems that imitate natural ecosystems can be designed for individual farm plots and beyond—from watersheds to entire cities. This is achieved through the use

of functional biodiversity, integration of complementary processes, the ecological clustering of industries, recycling, and re-localized production and consumption. Circular systems vary enormously in terms of their structure, function, and physical scale as they are adapted to rural and urban contexts. However, they share the following characteristics that contribute to making them resilient, sustainable, and productive.

The Proximity Principle and Appropriate Scale

Detailed life cycle analyses of food products such as orange juice, yogurt, and tomato ketchup have revealed the complex structure of modern food chains and highlighted how unsustainable they are. The example of tomato ketchup (Box 1) demonstrates the need for a fundamental shift to a circular economy model rather than improvements that remain locked into the dominant linear approach.

Box 1 The Hidden History of Ketchup

A bottle of tomato ketchup bought in a supermarket requires more than 150 processes and transport steps for its manufacture. Like the infrastructure needed for the production of most of our food products, it is dependent on fossil fuels, the industrial production of synthetic chemicals and gases, the manufacturing of plastics and polymers, mining and other extractive industries that are all highly capital intensive, dependent on heavy machinery, as well as profligate and wasteful in their use of energy and other nonrenewable resources.

By contrast, a circular economy approach to producing tomato

ketchup is more resource conserving and generates less pollution and waste. By growing tomatoes using agroecological methods, the use of both synthetic fertilizers and toxic chemical pesticides is avoided. Renewable energy systems—glasshouses and biogas—help extend the growing season and enhance crop yields in cooler climates. Spices are imported and sourced through fair trade. The tomato ketchup produced is packed in sterilized and recyclable glass bottles instead of disposable plastic bottles. This re-localization of production means that there are fewer steps involved in transport and the production of tomato ketchup. As a result, fewer resources are used while pollution and waste are reduced. The social and economic benefits include the creation of local jobs, more retention of wealth in the local economy, and a tomato ketchup product that is safer for the health of consumers and the environment.

In circular systems, farm and energy inputs are sourced locally and food products are distributed locally, with few intermediaries being involved. For example, in short food chains the number of intermediaries is minimized, with the ideal being direct contact between the producer and the consumer within the same limited geographical area. Typically, food is processed on the farm or in small nearby community processing units. There is also a significant switch from centralized, large-scale electricity generation to more decentralized small-scale renewable energy systems. The system focus is on "doing more with less," systematic recycling and reuse, the re-integration and re-localization of production processes, and synergies

and complementarities between different part of the system. Centralized and specialized global supply chains are replaced by resilient webs of diverse food and energy systems nested at different scales—from house clusters, municipal districts, whole cities or peri-urban belts linked with nearby farm land and the wider countryside.

All this improves food and energy security and reduces dependency on fossil fuels, food and energy imports, expensive farm inputs, fickle supermarket buyers, and price volatility on international commodity markets. The shift from linear to circular systems thus can generate multiple benefits and directly contribute to the regeneration of diverse local ecologies and economies (Box 2).

Box 2 Multiple Benefits of Circular Systems

Several case studies from Latin America show that the benefits of circular systems that integrate food and energy production with water and waste management can be significant. They include large reductions in fossil fuel consumption and greenhouse gas emissions as well as increased food, water, and energy security. Other benefits include the following:

- Increased local employment that is meaningful, secure, and rewarding
- Increased income from additional output and reduced input purchases
- Energy, food, and water security—supplies that are reliable, safe, and low cost (or free) once systems have been established
- Improvements in the local environment—less waste, water and air pollution, vermin, and disease.
- Reduction in or avoidance of the risks, dependency, and costs associated with

high-external inputs/supplies—for food, fossil fuels (for energy, transport, and machinery), fertilizer (and other farm inputs), and other materials.

- Contribution toward the creation of strong, resilient, and self-reliant communities through the development of local food webs and alternative food networks that directly reconnect consumers and producers
- Co-operative, just, and socially inclusive systems based on democratic decision making and greater citizen control in rural and urban settings.

Diversity, Multifunctionality, and Complexity

Reliance on functional diversity is a key organizing principle in circular food systems. For example, agroecological models of production combine a diversity of carefully chosen plant and animal species to maximize economic benefits and minimize risks, while ensuring a diverse food supply. Instead of relying on monocultures in which large areas are devoted to the production of a small number of (or perhaps a single) crops or livestock, agroecology harnesses biodiversity to develop multifunctional agricultures that mimic the structure and function of natural ecosystems: agroforestry, intercropping and polycultures, genetically diverse crops and livestock, mixed farming combining trees, crops, livestock and aquaculture at different scales—from home gardens to whole landscapes in rural and urban settings. Agroecological alternatives and their functional biodiversity integrate biological and ecological processes, such as nutrient cycling, nitrogen fixation, soil regeneration, and biological pest control, into food production processes. This helps minimize dependence on suppliers of external inputs and enhance the yields of biodiversity-rich agroecosystems. For example, a major study of 286 projects covering 37 million hectares in 57 countries found that, on average, crop yields increased by 79% in such

complex agroecological systems.

Systematic Reuse and Recycling

Circular economy models aim is to develop zero-waste by reducing inputs of external resources, and reusing and recycling organic matter, sewage, animal manure, metals, glass, plastics, and other materials that are currently treated as waste. In the United Kingdom where 40% of food is thrown away, processing mixed food waste using circular principles is estimated to generate US$1.5 billion annually for local municipalities while producing biogas and returning nutrients to agricultural soils.

Local Organizations

Local organizations sustain circular systems. Local organizations—individually and collectively—play a key role in the following:

- the adaptive management of the ecosystems and natural resources that sustain circular systems that combine food and energy production with the recycling of water and waste;
- the co-ordination of people, knowledge, and work to produce goods and services in the economy of these multifunctional circular systems;
- the decentralized governance of circular systems, including decisions about access to food, energy, water, and other resources.

Policies and Institutions for Circular Food Systems

There is an increasing number of successful initiatives that combine food and energy production with water and waste management in circular economy models at different scales—in both rural and urban settings. However, they remain isolated examples;

unsustainable industrial models are still the norm in many countries. The challenge now is to replicate sustainable circular systems on a much wider scale.

For both citizens and progressive policy makers, two priorities stand out: removing key obstacles that limit the spread of circular systems and redirecting public investments for the spread of circular systems in rural and urban areas. Achieving those two aims in practice involves several proposed actions, ranging from strengthening local organizations to upholding citizen rights to participate in policymaking

Strengthening Local Organizations

Throughout history, local organizations have been important in facilitating collective action and coordinated management of food systems and their environments at different spatial scales. Several organizations with different functions, powers, and responsibilities are usually needed to co-ordinate different activities within food systems and their wider environment. Such "nested organizations" operate at different scales and act in complementary ways. This web of polycentric and interacting organizations provides the institutional framework needed to manage dynamic complexity of food systems and the social and ecological spheres in which they are embedded.

However, many communities and their organizations are no longer in charge of managing their local food systems, and, importantly, they may not be "trusted" by state bureaucracies to be able to do so. As a result, communities and their local organizations may have become incapable of managing their environments and/or sharing management rights and responsibilities with others.

Re-establishing and/or strengthening local organizations can help deliver more sustainable and cheaper solutions for farming and food processing, storage, and

distribution as well as for decentralized energy production and the management of water and waste. A web of interacting local organizations can also provide the basis for decentralized governance and autonomous systems that directly respond to citizens' needs and priorities.

Promoting Gender Equitable Rights

In the face of widespread land and water grabs as well as the privatization of seeds and other natural resources, alternative policies are needed to ensure equitable rights of access, use, and control over land, water, seeds, and other natural resources in rural and urban areas. Improved security of tenure plays a vital role in the spread of agroecological innovations, ecodesigns, and resilient circular economy models. Policy makers can implement policies that strengthen customary and locally appropriate tenure systems while, at the same time, removing components that are discriminatory against women. Policy makers can replace current investment policies that favor land grabs and displacement of local communities with policies that support equitable access, use, and local control over land and territories in both urban and rural contexts.

Redistributing Public Goods

Agroecological practices, ecodesigns, and circular economy models require public goods such as appropriate rural and urban infrastructure, accessible credit, and support for training and capacity building. Funding is also required for the provision of local inputs (e.g., organic manure and composting units, seeds), local and community food-processing facilities (e.g., local abattoirs, solar dryers, storage and canning units), and equipment for decentralized, distributed microgeneration of renewable energies (e.g., solar, wind, biogas), and water recycling and purification.

Albala, K. The SAGE Encyclopedia of Food Issues pp. 232-238.

An enabling policy environment can help to ensure investments in these key public goods. At the same time, policy frameworks should enhance—rather than undermine—the individual and collective investments of farmers and citizens in rural and urban areas.

Transforming Research

The development of circular systems that combine food and energy production with water and waste management requires radically different knowledge from that currently offered by public and private sector research and disciplinary-based university departments. Investments in research and development that currently favor energy- and resource-intensive systems could be redirected to support decentralized food, energy, water and waste management systems based on circular economy models, agroecology, ecological design, biomimicry, socioecological resilience, and democratic control. Policies that support participatory research under citizen control and oversight as well as a network of decentralized demonstration and training centers that aim to strengthen local knowledge systems, organizations, and institutions are also important to enhance capacities for local innovation and their horizontal spread to more people and places.

Support Trade and Market Rules That Strengthen Resilient Local Systems

Currently, locally produced food, energy, and clean water struggle to compete with imported subsidized products. To protect the local economy, strengthen self-managed cooperatives and local businesses, and provide incentives for local food and energy production in rural and urban areas, trade rules and supply management policies can be introduced. For example, feed-in tariffs and internal markets can encourage decentralized and distributed microgeneration of renewable energies.

Albala, K. The SAGE Encyclopedia of Food Issues pp. 232-238.

Similarly, the spread of resilient food systems depends on the following: (a) replacing proprietary technologies and patents on biodiversity with locally adapted legal frameworks that recognize farmers' rights and guarantee equitable access to diverse seeds and livestock breeds; (b) replacing global, uniform standards for food and safety by a diversity of locally developed food standards that satisfy food and safety requirements; and (c) introducing local food, energy, and water procurement schemes.

Penalize Financial Speculations and the Externalization of Costs

Fiscal measures such as tax incentives can encourage the shift to sustainable systems. Relatively small taxes on financial exchange market speculations (e.g., Tobin tax and similar proposals)—and on other global money transactions—can be introduced through a multilateral agreement. It has been argued that this institutional innovation would more or less immediately provide significant amounts of funds for the development of circular systems needed for the regeneration of local ecologies and economies.

Stricter measures would also internalize the environmental and social costs of current food, energy, and transport, and the resulting revenues could then be used to support sustainable initiatives. Large corporations involved in food, agriculture, energy, water, and waste management would be the main—but not exclusive—targets of these measures. Such policies would enhance equity and enable a shift to a sustainable low carbon economy.

Upholding Citizen Rights to Participate in Policymaking

Governments have an obligation to support the fundamental human right of citizens to participate in shaping policies for the public good. More direct democracy and inclusive citizen engagement in framing food policies and regulations can be

encouraged by strengthening civil society and local organizations, using methods for deliberative and inclusive processes to link local voices into national and international policy making, expanding information democracy and citizen-controlled media, nurturing active forms of citizenship, and learning from the rich history of direct democracy.

But citizen participation is increasingly taking place in a context in which investors and transnational corporations rely on international arbitration to protect their rights as investors in the food system. Citizens, thus, need to secure legal redress against abuses of power. However, in many cases, legal redress may not be enough. History shows that these human rights need to be claimed through the agency and social mobilization of local communities and wider coalitions of citizens.

In conclusion, given the threats of climate change, peak oil, water scarcity, rising unemployment, and food insecurity, a shift toward sustainable circular systems can provide the material basis for local food sovereignty in rural and urban contexts.

Michel Pimbert

See also Food Sovereignty; Food Sovereignty Policy and Regulation; Permaculture

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